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The impact of Styrene-Acrylic Acid latex nanoparticles on colorectal cancer

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Background: Polymer nanoparticles (NPs) are promising approach for cancer treatment and detection because of their biocompatibility, biodegradability, targeting capabilities, capacity for drug loading and long blood circulation time.

Objectives: This study aims to evaluate the impact of polymeric NPs, styrene–acrylic acid latex, on colorectal cancer cells (HCT116).

Methods and Material: Human colorectal cancer (HCT-116) cells were cultured ($1.5x10^4$) and treated for 24 h and 48 h with various doses of the NPs (25 μg/mL, 50 μg/mL, 100 μg/mL, 200μg/mL, 400 μg/mL). Cell morphology changes were characterized using optical microscope and the cell number reduction was evaluated by DAPI staining and confocal microscope. In addition, the cell cytotoxicity of the NPs was evaluated using MTT assay and a 96-well plate reader.

Results and Discussion: The results showed that the 24-h treatments with 25 μg/mL and 50 μg/mL were not effective, but the 100 μg/mL, 200 μg/mL and 400μg/mL treatments showed gradual decrease in cell viability by 8%, 15% and 26%, respectively. At 48-h treatments, the cell cytotoxicity was 24% at 25 μg/mL treatment and significantly increased up to 52% of cell cytotoxicity at 400 μg/mL treatment. In addition, these data were confirmed by optical and confocal microscope pictures.

Conclusions: Styrene–acrylic acid latex nanoparticle are highly effective against colorectal cancer cells at high concentration and 48-h treatment. This indicates that these NPs are safe as drug delivery carrier when used at low concentration.

Effect of Amino Acid Substitutions in *OR9K2* on the Olfactory Neural Response activating Odor Molecules

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Background: Olfactory receptors (ORs) are expressed mainly in the sensory neurons, *OR9K2* is an olfactory receptor, which is located in the nose specifically on the plasma membrane. The main role of *OR9K2* is to initiate neuronal response and odorant signals.

Objectives: The purpose of the study is to identify the amino acid substitution in *OR9K2* that make the protein more favourable for odour molecules, which might help in early diagnosis and drug design.

Methods and Material: Using *in silico* tools, the study focused on selecting the most pathogenic amino acid substitution of *OR9K2* gene, based on the data retrieved from NCBI and previously identified prevalent non-synonymous SNPs (nsSNP) in Saudis using microarray analysis. The study also continues to collect nsSNPs (non-synonymous) of Saudi autistic patients using DNA sequencing. OR 9K2 (PDB ID: 6tp3.1.A) protein was homology modeled and validated using PROCHECK. Mutated OR9K2 proteins were generated using SwissPDB and undergo Protein – odour molecule interaction using molecular operating environment. Ten odor molecules were selected that are widely used in Arabian Gulf regions. All the selected odor molecules were docked against the wild and mutated proteins.

Results and Discussion: Of 463 nsSNPs, 12 most pathogenic nsSNPs were selected based on the cumulative score generated using nine bioinformatics tools and two more nsSNPs that are prevalent among Saudis were added. Thirty percent (Anisole, Piperonylacetone, delta-Guaiene) of the selected molecules did not interact with the wild *OR9K2*, interacted with the mutated *OR9K2*. Sanger sequence analysis revealed a frameshift mutation in the Saudi population.

Conclusions: Interaction of odor molecule with mutant, but not wild, *OR9K2* indicates that normal protein cannot activate the neural response of olfactory receptors, while the mutated protein (L285R) can activate ORs.

Oud Odorant Molecules Interact with Mutated *OR6C74* can Activate Olfactory Receptors

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Background: Previous studies demonstrate that variants of *OR6C74* gene are significantly associated with Saudi autistic patients. Interaction of odorant molecules with olfactory receptors (ORs) is the first step in odor identification.

Objectives: The study aims to identify the influence of amino acid substitutions in OR6C74 on structure, and its interaction with odorant molecules from oud on olfactory receptor activation.

Methods and Material: Non-synonymous SNPs (nsSNPs) were identified from NCBI and DNA variants prevalent in Saudi autistic patient through DNA exome microarray and DNA sequencing. Bioinformatics tools were used to detect the most deleterious nsSNPs according to their cumulative score. Homology model of OR6C74 was validated and mutated to create pathogenic amino acid substitutions. The most 10 widely used odor molecule structures were retrieved from PubChem. Molecular docking of wild and mutant proteins with odorant molecules were achieved using Molecular Operating Environment.

Results and Discussion: A total of 387 nsSNPs were selected and analysed for the pathogenicity on protein structure. All ten selected odour molecules were docked against the wild and the mutated *OR6C74*. Eight of ten odour molecules showed highest binding affinity with mutant compared to wild *OR6C74*. The mutated G86D shows the highest binding (S score: −4.7492, −4.6046, −4.1187 and −4.6170 kcal/mol) interaction with four odour molecules such as 1-Methoxy-4-methylbenzene, 3,4-Dihydrocoumarin, Benzaldehyde and Guaiacol.

Conclusions: Docking results show that the mutated *OR6C74* has a stronger binding affinity than the wild protein, which can influence mutated subjects to activate olfactory receptors and respond quicker than the normal subject. Among the top 10 used odour molecules is toluene, which binds more strongly to the mutated *OR6C74* than wild. The presence of toluene in habitat can trigger the olfactory receptors in the subjects with mutated *OR6C74* gene

Effect of magnetic iron oxide (Fe_3O_4) nanoparticles on germination, growth, and photosynthesis in barley (*Hordeum vulgare* L.) grown under constant magnetic field

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Background: Nanoparticles (NPs) are commonly defined as particles with sizes between about 1 and 100 nm which exhibit characteristics not found in bulk materials. Fe_3O_4 is a magnetic NP that has an unrecognized effect on plant growth and improvement under a continual magnetic field (MF).

Objectives: The aim of this study is to observe the effects of Fe_3O_4 NPs (50-100 nm in size) in barley (*Hordeum vulgare* L.) under varied MF conditions.

Methods and Material: For this purpose, Fe_3O_4 NPs were characterized in terms of their sizes and composition by using TEM (transmission electron microscope) and XRD (X-ray diffraction) analyses, respectively. Then, 500 mg/L of NPs was applied to barley at seed and growth stages under varied MF conditions (22, 42, 125, and 550 mT). The growth, biomass, protein content, chlorophyll level, and catalase enzyme activity of the plant tissues were observed continuously for 2 weeks. A confocal microscope was used to observe possible cell damage at the root tip. Photosynthesis, electron transport rate and chlorophyll florescence of plants were measured by PAM (pulse-amplitude modulation) fluorometer.

Results and Discussion: Results revealed that the NPs-treated samples under 125 and 550 mT exhibited increased germination rate (80%) compared to untreated samples (60%). The confocal microscope observation showed some injured cells at the root tips upon combined MF and NPs treatment. However, the injury did not cause growth retardation at low MF doses. On the other hand, NPs-treated samples have a more positive effect on growth enhancement than untreated samples when exposed to the continuous MF. Moreover, the light-adapted electron transport rate parameter also increased in the NPs-treated samples.

Conclusions: Overall, Fe_3O_4 NPs with MF application stimulates the growth of barley. Even under a strong MF condition, Fe_3O_4 NPs demonstrated a powerful effect in enhancing plant growth. These results suggest that iron oxide (Fe_3O_4) nanoparticles exhibit a potent effect in stimulating plant growth under magnetic field conditions.

Efficacy of Dexamethasone in the Treatment COVID-19 Patients

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Background: The global pandemic of COVID-19 is a viral respiratory illness caused by the novel coronavirus, SARS-COV-2. Currently, no treatments or vaccines are available to prevent this disease, consequently causing a burden on healthcare sectors worldwide. There is compelling evidence that the use of synthetic corticosteroid dexamethasone can be helpful and beneficial in the treatment of COVID-19 patients.

Objectives: To determine the mechanism of action, characteristics, efficacy and limitations of dexamethasone as an antiviral agent for the clinical outcomes of COVID-19 patients in critical condition.

Methods and Material: An online search was conducted using scientific databases for studies associated with the use of corticosteroids and the use of dexamethasone on viral respiratory illnesses including SARS, MERS and COVID-19 from 1st January 2020 to 23 July 2020.

Results and Discussion: Co-administration of systemic Dexamethasone with other antiviral agents may improve clinical outcomes in COVID-19 patients suffering from severe respiratory symptoms. It can reduce viral clearance and prevent a cytokine storm. However, it can delay viral clearance due to its immunosuppressive effects and may not always improve the prognosis of disease.

Conclusions: Dexamethasone suppresses inflammation by mimicking anti-inflammatory hormones and can be useful for oxygen and ventilator dependent COVID-19 patients. Further studies and large-scale clinical trials are needed to provide robust evidence of its efficacy.

Tamoxifen–titanium silicate nanoparticles inhibit the cell proliferation of tamoxifen resistant cervical cancer cells

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Background: Tamoxifen (TAM) attaches to estrogen receptors (ERs) at the cells surface of breast cancer cells, resulting in inhibition of cell proliferation. Low or negative ERs expression at cancer cells surface such as cervical cancer cells (HELA) will result in TAM resistant.

Objectives: This study aims to enhance the delivery of tamoxifen (TAM) into a negative or low estrogen receptor (ER) expression cancer cells by conjugating TAM to titanium silicate nanoparticles.

Methods and Material: HELA (ER-negative) were cultured in a 96-well plate and treated with varied doses (20, 80, 160, 320 μg/ml) of TAM + titanium silicate, TAM alone or titanium silicate alone. The optical microscope was used to check the cell morphology and number reduction. The cytotoxicity of the nanoparticle and TAM was evaluated by cell viability assay (MTT) and 96-well plate reader. LC_{50} was calculated and statistical analysis were performed using T-test.

Results and Discussion: HELA cells treated with tamoxifen alone (LC_{50}: 318.5923 μg/ml) or titanium silicate alone (LC_{50}: 701.26 μg/ml) showed a very low response and no change at cell morphology or number at the used doses. On the other hand, treatment with TAM + titanium silicate conjugate, resulted in very high cell cytotoxicity (LC_{50}: 32.59 μg/ml) in comparison to TAM or titanium silicate. This indicates that tamoxifen alone or titanium silicate alone is not toxic to the cells, but when they are conjugated together they show high activity against negative ER cells (HELA cells).

Conclusions: This study showed that titanium silicate enhance the delivery of TAM into cervical cells. In addition, resistant cancer cells to TAM that have low ER receptors can be treated with TAM + titanium silicate nanoparticles.

Effect of Magnetic Latex Nanoparticles (St + DVB + MMA) on Cervical Cancer Proliferation

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Background: Magnetic nanoparticles (MNPs) have been widely used in cancer diagnosis and treatment. MNPs are particularly very small in size but of a large surface area for a better magnetic response, which makes it very useful in tumor treatment.

Objectives: To evaluate the effect of superparamagnetic nanoparticles (core-shell (styrene (St)+ divinylbenzene (DVB)+ methacrylic acid (MAA))) on the drug-resistant cervical cancer cells (HELA).

Methods and Material: The average hydrodynamic size of the MNPs was determined by a Malvern Zetasizer and the surface structure was characterized by TEM. Human cervical cancer cells (HELA ($1.5x10^4$)) were cultured in DMEM medium and exposed to various doses of the MNPs (0, 25, 50, 100, 200 and 400 μg/mL) for 24 and 48 h. The effect of the MNPs was observed on HELA by optical and confocal microscopes and MTT cell viability assay. The resulted MTT data were subjected to statistical analysis (*t* test).

Results and Discussion: The hydrodynamic particle size of the final magnetic latex particles was found to be around 400 nm and the zeta potential was negative. In addition, confocal microscopy pictures showed high entry of MNPs into the cells with low cytotoxicity after 24h of treatment, this indicates that these MNPs may be used for cancer imaging. *In vitro* study of the latex MNPs showed high cytotoxicity in a dose-dependent matter against the HELA cervical cancer cell line. The 24-h treatment showed significant effect with very low margin difference between the lowest and highest treatment concentrations. On the other hand, at 48h treatment, the MNPs cytotoxicity increased with the concentration to reach 58% at 400 μg/mL.

Conclusions: In summary, the MNPs was significantly effective against cervical cancer cells proliferation after 48h of treatment. In addition, latex MNPs showed easy access to HELA cells, which is a characteristic that can overcome the resistance of cervical cancer cells.

Impact of variations in *DRD2* gene on the structure of DRD2 protein and interaction with risperidone: A pharmacogenetics study

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Background: There has been extensive research on dopamine receptor subtype D2 gene that takes part in dopaminergic pathway. Recent studies highlighted the importance of genetic variants and its possibility to modulate the neuropsychiatric response to risperidone drug but there was no specific predictable genetic marker that has been identified yet.

Objectives: To determine the most effective amino acid substitutions on the structure of mutated DRD2 protein, and asses its influence on the docking of risperidone molecule to their receptor on DRD2.

Methods and Material: A total of 18671 genetic variants of *DRD2* gene were retrieved from NCBI as well as identified through DNA exome microarray and DNA sequencing of Saudi autistic patients, and analyzed via in silico tools (SIFT, SNAP2, PolyPhen-2, PANTHER, PROVEAN, SNPs&GO, PhD-SNP, CRAVAT and CONDEL) to predict the most pathogenic non-synonymous SNPs (nsSNPs). The most pathogenic nsSNPs and Saudi subject variants of wild and mutant DRD2 protein were subjected for molecular docking with risperidone molecule.

Results and Discussion: Rigorous *in silico* analysis predicted the most 16 pathogenic nsSNPs based on the cumulative score generated using nine tools, and additionally one prevalent nsSNP in Saudis was also added. All 17 variants selected were found to be structurally varied from the wild by calculating root mean square deviation (RMSD), and C126W (RMSD 0.07 Å) showed highest changes. Of the 17 amino acid substitutions, F198C (S score: -7.0752 kcal/mol) showed highest deviation in the binding affinity compared to the wild (S score: -7.5381 kcal/mol) on the structure-based docking with risperidone using MOE on the binding packets at the active site.

Conclusions: Highly pathogenic genetic variants of *DRD2* gene influence the binding affinity of risperidone and it could be one of the reasons to explain the inter-individual variation in neuropsychiatric response efficacy and toxicity in different patients based on their *DRD2* genotype.

The underlying mechanism of tocilizumab in SARS-CoV-2: A systematic review

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Background: A new coronavirus, named 2019-nCoV/SARS-CoV-2, is responsible for worldwide pandemic. Stimulation of inflammatory cytokines was seen during the acute phase of infection. Tocilizumab, known as humanized IL-6-blocking treatment given for chronic autoimmune diseases or connective tissue disease, may be beneficial and prevent the development of severe COVID-19 symptoms in selected patients.

Objectives: Various therapeutic strategies have been practiced for decreasing COVID-19 symptoms. The aim of current study was to assess the therapeutic role of tocilizumab in reducing the life-threatening effect COVID-19 in patients by reducing their level of IL-6.

Methods and Material: A PRISMA-based protocol was used for collection of various articles and press release. English language articles were selected from PubMed, Scopus, Medline and Google Scholar published from 15th January 2020 to 20th July 2020. The search terms included combinations of SARS, corona, SARS-COV-2, cytokine storms, antiviral, IL-6 and tocilizumab.

Results and Discussion: Cytokines have a significant role in immune response, and IL-6 might play a key role in the cytokine storm. IL-6 is one of the important inducers of the acute-phase response. Interfering with IL-6 by Tocilizumab might be a promising therapeutic drug for severe COVID-19 patients. Tocilizumab is a humanized anti-IL-6R antibody, which acts by blocking the IL6 receptor, consequently replacing IL6 receptor. Several animal models and human studies have reported that tocilizumab treatment significantly reduced the severity of COVID-19 pneumonia and associated symptoms.

Conclusions: Tocilizumab has the ability to block COVID-19-induced cytokine storm by modulating including releasing of pro-inflammatory interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), and IL-12 in COVID-19 patients.

In Silico Approaches: The Composition Variations of SARS-CoV-2 Spike Protein and Human ACE2 Contribute to the level of Infection

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Background: SARS-CoV-2 is causative of pandemic COVID-19, There is a sequence similarity between SARS-CoV-2 & SARS-CoV; however, SARS-CoV-2 RBDs (receptor-binding domain) binds 20 fold strongly with human angiotensin-converting enzyme 2 (hACE2) than SARS-CoV.

Objectives: The study aims to investigate protein–protein interactions (PPI) of hACE2 with SARS-CoV-2 RBD between wild and variants to detect the most influential interaction.

Methods: Variants of hACE2 were retrieved from NCBI databank, and subjected to determine the most pathogenic nsSNPs. Probability of PPIs, which determines the binding affinity, between hACE2 genetic variants and RBD were investigated. Composition variations at the hACE2 and RBD were processed for PatchDock and refined by FireDock for the PPIs.

Results and Discussion: Twelve nsSNPs were identified as being most pathogenic from SNPs (n=7489) in *hACE2* using 8 bioinformatics tools. Eight RBD variants were complexed with 12 nSNPS of hACE2, the global energy scores (Kcal/mol) were calculated and classified as very weak (-3.93 to -18.43), weak (-18.42 to -32.94), moderate (-32.94 to -47.44), strong (-47.44 to -61.95), and very strong (-61.95 to -76.46) zones. Seven composition variants in the very strong zone [G726R-G476S; R768W-V367F; Y252N-V483A; Y252N-V367F; G726R-V367F; N720D-V367F and N720D-F486L] and three in the very weak zone [P263S-S383C; RBD-H378R; G726R-A348T] significantly ($p<0.00001$) varied for global energy score.

Conclusions: Zonation of the five zones were established based on the scores to differentiate the effect of hACE2 and RBD variants on the binding affinity. Moreover, our findings support that the combination of hACE2 and RBD are key players for the risk of infection, and this requires further laboratory studies.

Adsorption of cancer drug 5-Fluorouracil on carbon-doped hexagonal boron nitride using density functional theory

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Background: Hexagonal boron nitride (h-BN) have a crystal structure analogous to graphene with sp ^ 2 hybridized structure.

Objectives: In this work, we use density functional theory (DFT) to study the electronic properties of carbon-doped hexagonal boron nitride (h-BN) structure, and its use as a drug carrier for the cancer drug 5-Fluorouracil (FU).

Methods and Material: We used DFT, with two flavors, local density approximation (LDA), and generalized gradient approximation (GGA) to calculate the electronic properties of h-BN. Then, as an application to our study, we investigated the adsorption of the cancer drug FU on h-BN and carbon doped h-BN.

Results and Discussion: The density of states (DOS) of both calculations are generally similar the band gap is found to be 4.32 eV for LDA and 4.5 eV for GGA. We then constructed a 2 × 2 h-BN unit cell, having eight atoms, and dope the system with carbon, at a N site, and a B site. We found that the gap decreased to 3.89 eV former, and to 3.91 eV to the latter. Then, we investigated the adsorption of FU on carbon-doped h-BN. We constructed a large 6 × 6 h-BN unit cell, and placed the FU molecule on it at a distance of 3 A. The system is structurally relaxed, and we calculated the adsorption properties of FU on pristine h-BN, and carbon doped h-BN. We consider carbon doping of h-BN at the nitrogen and boron sites. We find that FU adsorbs on pristine h-BN with an adsorption energy of 0.38 eV, and that the adsorption is enhanced on carbon doped h-BN, with the highest adsorption, 0.58 eV, with the carbon at the boron site.

Conclusions: Based on our calculations, carbon doping enhances the drug loading of the FU molecule on h-BN. Therefore, we recommend using carbon-doped h-BN as a drug carrier for FU.

Deep Learning Vs. Machine Learning Based Screening of COVID-19 Using Chest X-Ray Images

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Background: COVID-19 pandemic has affected most countries worldwide; the latest recorded number was 14 million confirmed cases. Some studies experiment on using deep learning models to diagnose COVID-19 using medical imaging such as chest X-ray (CXR) images. However, the use of deep learning and machine learning are limited.

Objectives: This study aims to classify the CXR images into either normal or infected by COVID-19 using deep learning and machine learning and comparing the two approaches.

Methods and Material: Our dataset contains 143 images of posteroanterior view CXR for normal (n=67) and COVID-19 cases (n=76), 100 images for training, and 43 for testing. We used the Python programming language to implement the deep learning model to build and evaluate the Convolutional Neural Network (CNN) model. For the machine learning model, we first extract 36 features using Fiji ImageJ tool. We then used these features to build KNN and SVM models in python. We used feature selection and parameter tuning to produce better results for the models.

Results and Discussion: The deep learning model achieved an accuracy of 100% using the CNN model. The best results of the used machine learning techniques were after combining them with feature selection function that achieved 95% for KNN and 98% for SVM. From the results, we found that the deep learning model outperforms the other two machine learning models.

Conclusions: The deep learning model using CNN achieved better results than machine learning for classifying CXR either to COVID-19 cases or normal. Future studies may focus on experimenting using a larger dataset for CXR.

Factors influencing lung infection rate in SARS-CoV-2

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Background: SARS-CoV-2 caused COVID-19 pandemic originated at the end of 2019 in Wuhan city in China. Until now, there is no valid treatment or vaccine.

Objectives: To calculate the lung infection rate by X-ray images and determine the strength of the relationship between lung infection rate and patient records (if there are chronic diseases, age, and gender) of SARS-CoV-2.

Methods and Material: This study included 80 SARS-CoV-2 patients. Data were collected and cleaned in Microsoft Excel 2019 software. The ImageJ software was used to extract the density of X-ray images to calculate the lung infection rate. Obtained data were loaded data into R 4.0.2 software to implement a linear regression analysis to determine the strength of the relationship between lung infection rate and patient records.

Results and Discussion: Linear regression analysis showed that there is no relationship between lung infection rate and presence of chronic diseases (P-value = 0.521, 95% CI: -4.72, 9.23), age (P-value = 0.525, 95% CI: -0.28, 0.15), and gender (P-value = 0.693, 95% CI: -8.02, 5.35).

Conclusions: According to our analysis, there is no strength of the relationship between lung infection rate and any chronic disease, age, and gender.

Synthesis and Characterization of Magnetoelectric $BaTiO_3$/$Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ Nanocomposites for Multifunctional Device Applications

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Background: Multiferroic materials have been extensively investigated and have directed to prominent technological applications. Most of the single-phase multiferroic materials have many drawbacks, such as low remanent polarization and very weak ferroelectric/ferromagnetic responses. Magnetoelectric composite materials can overcome all these limitations. They have broad multifunctional applications including photovoltaics, energy harvesters, nano-electronic devices, sensors, storage devices, etc.

Objectives: We aim to synthesize magnetoelectric composites exhibiting better properties than single-phase multiferroic materials to be useful for multifunctional device applications.

Methods and Material: Magnetoelectric nanocomposites of $BaTiO_3$ added with different amounts of Nb substituted CoNi-ferrites were prepared. The ferroelectric $BaTiO_3$ nanopowders were firstly prepared through the high-energy ball-milling technique. On the other hand, Nb substituted $Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ nanosized spinel ferrite was synthesized through the hydrothermal method. After that, ferroelectric and magnetic powder phases were mixed, compacted into pellets and then heat treated at high temperature. The magnetoelectric nanocomposites were examined using XRD, TEM, SEM, UV-vis DRS, VSM and Impedance analyzer techniques.

Results and Discussion: The successful formation of the desired nanocomposites was confirmed by XRD patterns. XRD, SEM and TEM observations revealed the co-existence of ferroelectric $BaTiO_3$ and magnetic $Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ phases in the produced nanocomposites. The microstructural changed affect greatly the optical, magnetic and dielectric properties of $BaTiO_3$/$Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ nanocomposites. These composites could be potential candidates for multifunctional device applications.

Conclusions: The obtained findings revealed that the magnetoelectric $BaTiO_3$+x% $Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ nanocomposites could be potential candidates for multifunctional device applications.

Design and Development of Hallow Carbon Spheres of $Ni_{0.5}Co_{0.5}Ce_xDy_xFe_{2-2x}O_4$ for microwave absorbing applications

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Background: The family of spinel ferrites exhibits a set of outstanding specific properties including high saturation magnetization, smaller coercivity, and high thermal stability, which lead them promising in various fields ranging from high density magnetic recording media to microwave devices applications. Specific interesting characteristics involving electromagnetic waves absorption across a broad frequency band could be achieved through the combination of spinel ferrite magnetic nanoparticles and electrically conductive hollow carbon spheres.

Objectives: To develop hollow carbon spheres of $Ni_{0.5}Co_{0.5}Ce_xDy_xFe_{2-2x}O_4$ (x = 0.04 - 0.06) for the use in microwave devices applications.

Methods and Material: Carbon spheres of $Ni_{0.5}Co_{0.5}Fe_{2-2x}Ce_xDy_xO_4$ (x = 0.04 and 0.06) were produced through sonochemical approach followed by a hydrothermal treatment. Initially, carbon spheres were produced through hydrothermal method by treating the glucose in an aqueous solution in an autoclave for 10 h at 180°C. Then, carbon spheres along with various nitrates of Ni, Co, Fe, Ce and Dy were mixed in DI H_2O and stirred for 30 min. The pH was adjusted to 7 by NH_3 solution. The solution was subjected to ultrasound irradiation and then to hydrothermal treatment. Several characterization techniques were used such as XRD, SEM, TEM, UV-vis DRS, magnetization and microwave measurements.

Results and Discussion: The formation of cubic spinel ferrite phase with no secondary phases was checked via XRD technique. Spherical nanosized grains of hollow carbon spheres of $Ni_{0.5}Co_{0.5}Fe_{2-2x}Ce_xDy_xO_4$ were observed through SEM and TEM analysis. The prepared products revealed high microwave absorbing properties.

Conclusions: New set of excellent microwave absorbing materials consisting of hollow carbon spheres of $Ni_{0.5}Co_{0.5}Fe_{2-2x}Ce_xDy_xO_4$ were successfully prepared.

Synthesis and characterization of hallow carbon spheres of CeDy substituted NiCo spinel ferrites

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Background: Many attempts were done to produce microwave absorbing materials having better heat stability, large absorption band, great absorption rate, and low cost, etc. Among these materials, spinel ferrite showed outstanding electromagnetic properties like high chemical stability, mechanical hardness, low dielectric loss, and high electrical resistivity, etc. On the other hand, hollow sphere structures gained great interest due to their better stability, strong permeability, high specific surface area, good dispersion, etc.

Objectives: We aim to develop carbon microspheres as templates to produce hollow carbon microspheres of CeDy doped NiCo spinel ferrite for microwave absorbing applications.

Methods and Material: The experiment is based on two steps: firstly, carbon spheres were synthesized through hydrothermal method by treating aqueous solution of glucose in an autoclave for 10 h at 180°C. Secondly, carbon spheres of $Ni_{0.5}Co_{0.5}Fe_{2-2x}Ce_xDy_xO_4$ (where x = 0.00 and 0.02) were prepared using sonochemical approach followed by a hydrothermal treatment. Samples were washed and dried to get the final powder products. Several characterization techniques were used such as XRD, SEM, TEM, UV-vis DRS, magnetization and microwave measurements.

Results and Discussion: XRD patterns showed the formation cubic spinel ferrite without any impurities. TEM observations showed that hollow carbon spheres of CeDy substituted NiCo ferrites are spherical in shape with nanosized scale. High microwave absorbing properties were obtained in hollow carbon spheres of CeDy substituted NiCo ferrites.

Conclusions: Hollow carbon spheres of CeDy substituted NiCo ferrites were prepared for the first time with excellent microwave absorbing performances.

Effect of SiO_2 nanowires on Ferroelectric Barium Titanate Materials for Multilayer Ceramic Capacitors

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Background: $BaTiO_3$ materials are widely used as dielectric medium for multilayer ceramic capacitors (MLCC) due to its excellent electrical and dielectric properties. Nevertheless, they suffer from the subsequent drawbacks: maximum magnitude of dielectric constant is achieved close to Curie temperature (T_c) that is distant from the ambient temperature. Voluminous attempts have been done to surmount the limitations of BTO systems. Additives or dopants could considerably alter the microstructure, affect the dielectric properties, and vary the operational temperatures of modified BTO systems.

Objectives: The goal is to enhance the dielectric properties of $BaTiO_3$ by doping it with SiO_2 nanowires for MLCC applications.

Methods and Material: Samples of $BaTiO_3+xSiO_2$ ceramics, where $x \leq 0.2$wt% were produced through solid-state reaction route. Firstly, oxide powders of $BaCO_3$ and TiO_2 along with ethanol were mixed and grinded using ball milling technique. The obtained powders were washed, dried, and then calcined in a high temperature furnace. Afterwards, different concentrations of SiO_2 nanowires were added, mixed, then compacted into the form of discs by means of PVA, and finally sintered for 6h at 1250°C. The obtained ceramics were examined via XRD, TEM, SEM, UV-Vis DRS, and FT-IR techniques. The dielectric properties were also studied.

Results and Discussion: XRD patterns revealed the successful formation of the desired ferroelectric $BaTiO_3+xSiO_2$ ceramics. SEM observations showed spherical-shaped grains for all samples. The band gap energies were also estimated for all ceramics. It was found that the dielectric and optical properties are strongly dependent on the microstructure development of synthesized ceramics. The current products could be promising for MLCC applications.

Conclusions: Ceramics of $BaTiO_3+xSiO_2$ nanowires (x=0–0.2) were successfully prepared. The enhanced dielectric and optical properties could make these ceramics as prospective applicants for MLCC.

Effects and Investigation of Titanium Oxide Nanowires Addition on High-Tc Superconductor YBCO Performances

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Background: Superconducting materials are one of great interest in allowing the energy to flow efficiently through them without generating unwanted heat and therefore without any loss of energy. $YBa_2Cu_3O_y$ (noted YBCO) is one of the most promising superconductors for several technological applications. However, the weak flux pinning of YBCO material limits its use in superconducting-based technological applications. Much efforts have been made to improve the superconducting parameters of YBCO material, particularly superconducting critical transition temperature (T_{co}), critical current density (J_c) and activation energy (E_a).

Objectives: The present study aims to introduce efficient artificial pinning centers within the YBCO material that inhibit the motion of vortices and hence improve its superconducting parameters.

Methods and Material: Products of $YBa_2Cu_3O_y + x\ TiO_2$ with $x = 0$ - 1 wt.% were prepared using solid-state reaction. Firstly, precursor of YBCO was formed by mixing powders of Y_2O_3, $BaCO_3$ and CuO. The mixture was subjected to calcination step. Once the precursor is obtained, different concentration of TiO_2 nanowires were added, pelletized and then heat treated in high-temperature furnace. The structure, morphology, optical and superconducting properties of various samples were characterized using XRD, SEM, UV-vis DRS and AC susceptibility techniques.

Results and Discussion: XRD analysis showed the orthorhombic structure of all YBCO/TiO_2 sintered samples. SEM showed the dispersion of TiO_2 nanowires between YBCO grains. The optical band gap energies for all samples were estimated and influenced by TiO_2 additions. Using the AC susceptibility measurements, the activation energy (E_a) was deduced and found to be enhanced with small amount of TiO_2 nanowires.

Conclusions: The obtained results indicated that the addition of TiO_2 nanowires within YBCO material could be effective route to improve the superconducting properties.

Color blindness diagnosis using fNIRS

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Background: Color blindness can occur because of damage to the eyes or brain, or it could be passed on genetically. The disease used to be diagnosed by two old ways, the Ishihara test and the color arrangement method other than diagnosing it with brain-imaging devices. One of the most effective brain-imaging devices is the functional near-infrared spectroscopy (fNIRS) or Optical Topography, as it is a non-invasive brain-imaging device that helps to assess cerebral activity by detecting the changes of oxygenated and deoxygenated hemoglobin concentration in the blood.

Objectives: The purpose of this study is to identify the active areas of the visual cortex when stimulating different colors in front of those who are color blind.

Methods and Material: This case–control study included 44 people with color blindness and 44 with normal vision, aged 4-25 years, who were living in Dammam, Saudi Arabia. Demographic data was elicited using a questionnaire. All participants were exposed to a single color and the areas for each signal was spotted. The device was set-up and connected to a screen to read and record the signals.

Expected Results: Each area of the visual cortex showed activity on different sides when stimulating different colors on the screen. The brain revitalization processes in people with normal vision differs from that in color-blind patients. The absence of the signals in a specific area indicates that the person does not see this color and can be diagnosed with this disease. Therefore, using fNIRS may enable easier diagnosis of color blindness.

Conclusions: fNIRS has potential to diagnose color blindness by successfully detecting signals in different regions of the brain, and its distinctive characteristics may be especially useful in younger children.

Preparation and Dielectric Properties of Graphene Nanoplatelets-Doped $BaTiO_3$ Nanocomposites for Electromagnetic Interferences (EM)

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Background: The electromagnetic (EM) emissions from a comprehensive variety of electronic circuits may degrade to effectiveness of other devices or may adversely affect human health. To resolve these complications, numerous research have been done on electromagnetic wave absorbers. Barium titanate ($BaTiO_3$) is typically found to have the characteristic of microwave absorption. Nevertheless, there are certain characteristic flaws (e.g., unsatisfactory value of reflection loss and limited absorption band width) that prevent pure barium titanate from operating as electromagnetic wave absorbers.

Objectives: This study aims to synthesize $BaTiO_3$ doped with graphene nanoplatelets to enhance the dielectric and microwave absorbing properties.

Methods and Material: Series of $BaTiO_3$ doped with different content of graphene nanoplatelets samples were prepared by solid state reaction approach. Polyvinyl alcohol (PVA) was used as binder to get densified disks during compacting. The disks were subjected to heat treatment at 1200°C for 5 h. The produced products were analyzed by XRD, SEM, optical, and dielectric measurements.

Results and Discussion: XRD patterns of the $BaTiO_3$/graphene composites showed that various products are consistent with the pure phase of $BaTiO_3$ (tetragonal structure) with no diffraction peaks other than those from $BaTiO_3$/graphene are identified in these products, revealing the high purity of produced nanocomposites. The optical as well as the dielectric properties were investigated and correlated with microstructure changes. The composite with dense microstructure revealed good dielectric traits. This composite is supposed to have potential applications in EM wave absorbers.

Conclusions: Composite of $BaTiO_3$/Graphene were well prepared using solid state reaction. The composite with better dielectric traits is assumed to have potential applications in EM wave absorbers.

Improved Critical Current Density in YBCO added carbon nanotubes Superconductor

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Background: YBCO superconducting material has become very valuable for various technological applications. However, it suffers from weak critical current density (J_c) under an external magnetic field. This problem could be resolved by addition of artificial nano-sized entities inside YBCO superconductor. Recently, carbon nanotubes (CNTs) have attracted the attention of researchers due to their excellent structural and functional characteristics such as high mechanical strength and high electrical properties.

Objectives: Our objective is to enhance the value of critical density of YBCO material under external magnetic field, and hence improve its performance for practical applications.

Methods and Material: The synthesis of YBCO+CNTs samples is achieved by using solid state route and following two steps of sintering. Firstly, powders of Y_2O_3, $BaCO_3$ and CuO were stoichiometrically mixed, pelletized and then calcined to form precursor of YBCO. After that, different amounts of carbon nanotubes were added to precursor of YBCO. Both YBCO and CNTs powders were grinded together, compacted and sintered at 950°C. Final samples were then characterized using XRD, SEM and VSM techniques. The electrical resistivity experiments were also performed to evaluate the superconducting features of the products.

Results and Discussion: XRD analysis showed the formation of single YBCO phase with orthorhombic structure for all samples. SEM observations revealed the dispersion of CNTs inside YBCO grains with the presence of crystal defects. The electrical measurement confirmed that all samples exhibit a superconducting transition. The magnetic field dependence of critical current density $J_c(H)$ is deduced using VSM technique. The findings of this study indicated an enhancement of $J_c(H)$ with CNTs inclusion.

Conclusions: Samples of YBCO superconductor with different amounts of CNTs addition were successfully synthetized. All results proved the relevant effect of CNTs addition on the YBCO performance.

Synthesis and Investigation of CeDy doped NiCo ferrites Hallow Spheres with enhanced microwave absorbing performances

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Background: Magnetic spinel ferrite nanoparticles raised the enthusiasm owing to their capability to be used as microwave absorbers, gas sensors, catalysis, photocatalysts, etc. Many attempts were made to synthesize new promising microwave absorbing materials with enhanced performances. The combination of magnetic spinel ferrite nanoparticles and electrically conductive hollow carbon spheres could lead to excellent microwave absorbing properties.

Objectives: The objective is to design magnetic nanoparticles $Ni_{0.5}Co_{0.5}Ce_xDy_xFe_{2-2x}O_4$ (x = 0.08 - 0.10) hollow spheres and enhance their magnetic and microwave properties.

Methods and Material: $Ni_{0.5}Co_{0.5}Fe_{2-2x}Ce_xDy_xO_4$ (where x = 0.08 and 0.10) hallow spheres were produced via sonochemical approach followed by a hydrothermal treatment. For that reason, aqueous solution of glucose was subjected to hydrothermal treatment for 10 h at 180 °C to produce carbon spheres. The obtained carbon spheres were mixed with various nitrates of Ni, Co, Fe, Ce and Dy in DI H_2O and stirred for 30 min. Then, the pH = 7 was adjusted by adding some drops of ammonia solution. The solution was subjected to ultrasound irradiation and then to hydrothermal treatment. Afterward, the solution was filtered and dried to get final powder product. Products were characterized by means of XRD, SEM, TEM, UV-vis DRS, magnetization and microwave measurements.

Results and Discussion: According to XRD analysis, $Ni_{0.5}Co_{0.5}Fe_{2-2x}Ce_xDy_xO_4$ (where x = 0.08 and 0.10) hallow spheres with no secondary phases were successfully formed. The final products displayed spherical grains at nanosize scale as revealed by SEM and TEM observations. The microwave absorbing properties of samples were examined, and an enhancement was achieved.

Conclusions: $Ni_{0.5}Co_{0.5}Fe_{2-2x}Ce_xDy_xO_4$ (where x = 0.08 and 0.10) hallow spheres showed enhanced microwave absorbing properties.

Effect of Nb doped CoNi ferrites on the structural, optical, magnetic and dielectric properties of $BaTiO_3$ materials

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Background: Recently, the introduction of magnetic nanomaterials in the nonmagnetic perovskite $BaTiO_3$ ferroelectric material has attracted the researchers to add the functionality of magnetism within the host crystal that develop their utilization in multi-functional electronic devices. The search of an efficient approach to produce ferroelectric-magnetic composites is a crucial aim of several researchers.

Objectives: We aim to synthesize ferroelectric-magnetic composites that display enhanced performances to be utilized in numerous electronic devices.

Methods and Material: Ferroelectric-magnetic composites of $BaTiO_3$ + x % $Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ were prepared via solid state reaction. Magnetic nanoparticles of Nb substituted CoNi ferrites were synthesized by hydrothermal method. On the other hand, ferroelectric $BaTiO_3$ nanopowders were prepared via solid state reaction through the use of high energy ball milling machine. Afterward, the two phases were mixed in an agate mortar, compacted into the form of disks by the help of polyvinyl alcohol (PVA) and then subjected to heat treatment at high temperature. The structure, microstructure, optical, magnetic and dielectric properties were investigated by XRD, SEM, TEM, UV-vis DRS, VSM and Impedance analyzer techniques, respectively.

Results and Discussion: XRD, SEM and TEM results revealed the presence of the ferroelectric $BaTiO_3$ and the magnetic $Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ phases within the prepared nanocomposites. The optical, magnetic and dielectric properties are governed by structure and microstructure of $BaTiO_3$ + *x* % $Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ nanocomposites. The introduction of suitable magnetic phase into $BaTiO_3$ could enhance and develop new generation of multifunctional electronic devices.

Conclusions: The introduction of suitable amount of magnetic $Co_{0.5}Ni_{0.5}Nb_{0.02}Fe_{1.98}O_4$ phase into the ferroelectric $BaTiO_3$ could enhance and develop their utilization in multifunctional electronic devices.

Design of enhanced magnetoelectric nanocomposites $BaTiO_3/xCo_{0.5}Zn_{0.5}Tm_{0.01}Fe_{1.98}O_4$ for high-specificity anticancer drug delivery

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Background: The ability to use nanoparticles as drug delivery system is considered one of the most appreciated application of nanomedicine. Traditional chemotherapy is not only affecting cancerous cells but also normal cells, which leads to a dangerous side effect. That challenge can be overcome by using more specified controlled form of nanomaterials known as magnetoelectric nanocomposites that combine ferroelectric and magnetic effects.

Objectives: In this study, we aim to design promising magnetoelectric nanocomposites with enhanced structural, morphological, magnetic and dielectric properties that can be used as nanocarriers for high-specificity drug delivery.

Methods and Material: Magnetoelectric nanocomposites consist of mixture of $BaTiO_3/xCo_{0.5}Zn_{0.5}Tm_{0.01}Fe_{1.98}O_4$. The sonochemical approach was used to prepare the nanosized spinel ferrite $Co_{0.5}Zn_{0.5}Tm_{0.01}Fe_{1.98}O_4$ phase, while the solid-state method was used to prepare ferroelectric $BaTiO_3$ phase. The obtained nanocomposites were characterized by X-ray diffraction for the crystal structure examination and scanning and transmission electron microscopes (SEM and TEM) for the morphology and microstructure observations. The dielectric, polarization, magnetic and optical properties were also studied.

Results and Discussion: XRD patterns showed the successful formation of the desired nanocomposites. SEM and TEM observations showed the co-existence of ferroelectric $BaTiO_3$ and $Co_{0.5}Zn_{0.5}Tm_{0.01}Fe_{1.98}O_4$ phases in the produced nanocomposites. The dielectric, magnetic and optical properties were strongly dependent on the microstructure development of synthesized nanocomposites. The produced nanocomposites will be used as nanocarriers for high-specificity anticancer drug delivery.

Conclusions: $BaTiO_3/xCo_{0.5}Zn_{0.5}Tm_{0.01}Fe_{1.98}O_4$ magnetoelectric nanocomposites were prepared for the first time. These nanocomposites could be potential candidates for high specificity of drug delivery to cancer cells.